MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

EEL1016 – ENERGY CONVERSION I

(LE)

15 MARCH 2019
9 AM – 11 AM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This examination paper consists of 5 pages with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

Figure Q1 shows a positive sequence, balanced three-phase star-connected source with rms phase voltage of 220 V. The per-phase impedance value of a three-phase balanced delta connected load is equal to $Z_\Delta = 24 + j9\ \Omega$ and the source impedance, Z_G is equal to $20 + j10\ \Omega$.

(i) Do the delta to star transformation on the load and determine the total per phase impedance of the circuit. [2 marks]

(ii) Redraw the new Y-Y connected balanced three-phase circuit. [4 marks]

(iii) Based on the new three-phase Y-Y connected circuit in Part (ii), draw the phase-*a* equivalent circuit and calculate the line currents, phase voltages at the load, three-phase complex power drawn by the loads, three-phase real and reactive powers drawn by the load. [14 marks]

(iv) Determine the three-phase delta-connected load currents, I_{AB}, I_{BC} and I_{CA} shown in Figure Q1. [3 marks]

(v) What is the power factor of the system and why it is a customary to state whether it is a leading or lagging power factor? [2 marks]

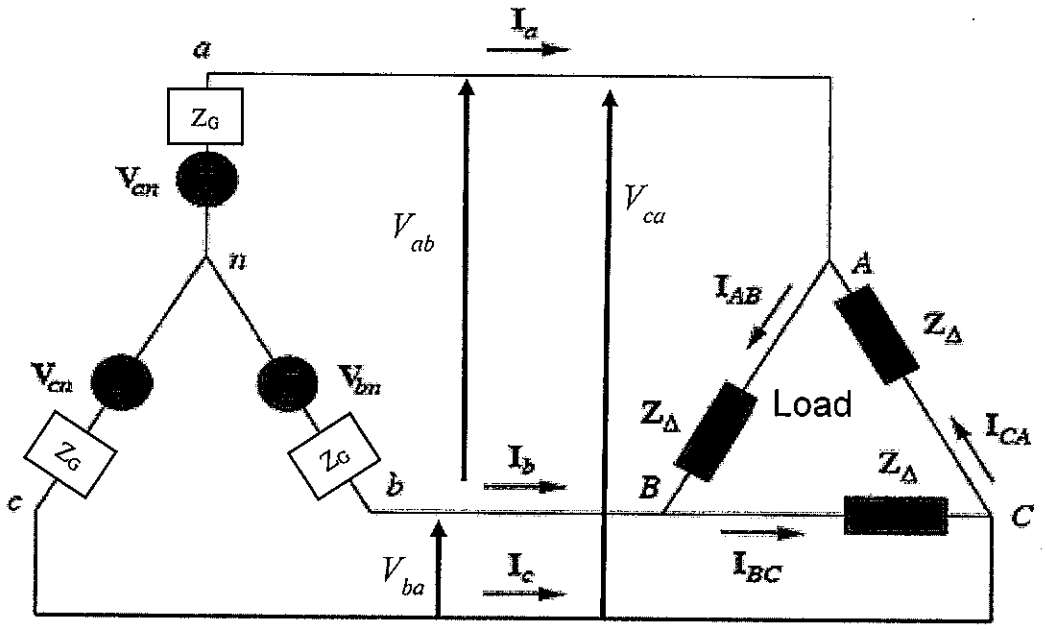

Figure Q1

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Question 2

(a) Power transformers are constructed on one of two types of cores, namely *core form* and *shell form*. With aids of diagrams, briefly explain the different between these two types of construction. [4 marks]

(b) A 15-kVA, 2300/230-V transformer is to be tested to determine its excitation branch components, its series impedances and its voltage regulation. Test data obtained from the tests are as following:

Open-circuit test	Short-circuit test
$V_{OC} = 2300$ V	$V_{SC} = 47$ V
$I_{OC} = 0.21$ A	$I_{SC} = 6.0$ A
$P_{OC} = 50$ W	$P_{SC} = 160$ W

(i) Based on the data given above, determine the location of the tests whether it was performed on the low- and/or high-voltage side of the transformer. Justify your answer. [2 marks]

(ii) Determine the excitation branch components and its series impedances of the transformer referred to the high-voltage side. Sketch and label the resultant equivalent circuit of the transformer. [11 marks]

(iii) Calculate the full-load voltage regulation at 0.8 leading power factor and hence sketch the corresponding phasor diagram of the transformer. [8 marks]

Question 3

(a) Sketch and briefly explain the Torque-speed curve of an induction motor. [6 marks]

(b) A 208-V, 10hp, four poles, 60 Hz, Y-connected induction motor has a full-load slip of 5 percent. Determine the following:

(i) the synchronous speed of the motor. [2 marks]

(ii) the rotor speed at rated load. [2 marks]

(iii) the rotor frequency at rated load. [2 marks]

(c) Figure Q3 shows the equivalent circuit of a 480-V, 60 Hz, 50-hp, three-phase induction motor. The motor is drawing 60 A at 0.85 power factor lagging. The stator copper losses are 2 kW, and the rotor copper losses are 700 W. The friction and windage losses are 600 W, the core losses are 1800 W, and the stray losses are negligible.

(i) Sketch and label the power flow diagram of the induction motor. [5 marks]

(ii) What is the air-gap power, P_{AG}? [3 marks]

(iii) Find the power converted, P_{Conv}. [1 mark]

(iv) What is the output power, Pout? [2 marks]

(v) Calculate the efficiency of the motor. [2 marks]

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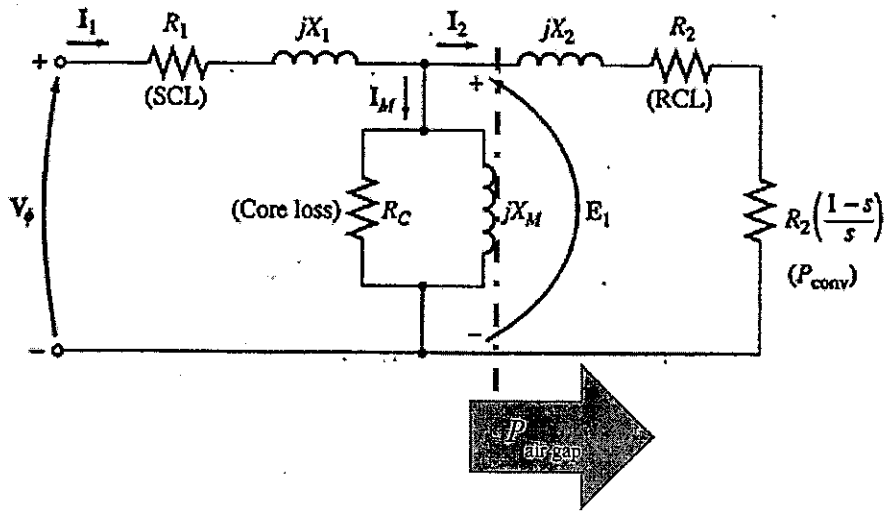

Figure Q3

Question 4

(a) Figure Q4(a) shows the circuit of a Synchronous Generator. Explain the operation principle of the machine. [10 marks]

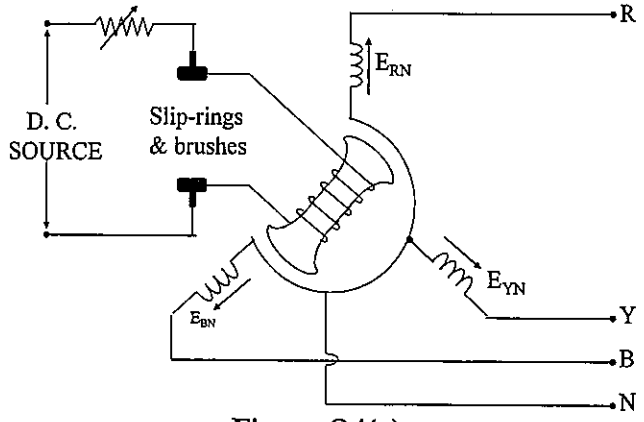

Figure Q4(a)

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(b) The equivalent circuit of a Synchronous Generator that has been derived contains THREE quantities that must be determined in order to completely describe the behaviour of a real Synchronous Generator.

(i) Sketch the per-phase equivalent circuit (that include the field of excitation circuit) of the Synchronous Generator and hence write the equation that describe the output voltage, V_ϕ. [6 marks]

(ii) State the above-mentioned THREE quantities that need to be determined in describing the behaviour of a real Synchronous Generator. [3 marks]

(iii) The following readings are taken from the results of open-circuit and short-circuit tests on a 10-MVA, three-phase, Y-connected, 13.8-kV, two-pole turbine generator driven at synchronous speed:

Field current, A: 170
Armature current, short-circuit test, A: 418
Line-to-line voltage, open-circuit test, V: 13,500
DC voltage applied to two of the terminals, V: 30
DC current, A: 45

Determine the value of the synchronous reactance and armature resistance in ohms per phase that would be used in the generator model at the rated conditions. [6 marks]

End of Paper.